Wheat lag

Growth in yields of the cereal must double if the Green Revolution is to be put back on track.

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Wheat is widely considered to be the world’s most important crop, and Norman Borlaug knew a thing or two about how to grow it. The US agronomist developed varieties that could better resist disease and gave higher yields. In doing so, he saved an estimated one billion people from starvation.

This week marks a century since Borlaug’s birth, so what better time to consider why millions still go hungry, and to ponder how the next Green Revolution can be kick-started? At a meeting in Mexico this week, organized by the International Maize and Wheat Improvement Center (CIMMYT) in collaboration with the Association for Agricultural Research and Experimentation of the State of Sonora, researchers will look again at the prospects for wheat. Although wheat consumption is growing, the investment needed to build on Borlaug’s legacy is scarce.

Wheat provides 20% of the dietary energy for the world’s population. Yet growth in yields has stagnated at around 0.9% per year over the past decade — by contrast, maize (corn) yields grow by almost double that at approximately 1.6% per year. To meet future demand for food, researchers say that wheat yields must grow by 1.7% each year. That will require investment. The total global spend on wheat breeding and research, around US$500 million per year, is currently one-quarter of that spent to improve maize.

The discrepancy arises because seed companies can make higher profits from maize than from wheat. Maize is a hybrid crop that produces seeds with poor yields, so there is little incentive for farmers to keep and replant them. To get the best results, they must buy new maize seeds each year. Seed producers get no such annual income from wheat because farmers can reap and replant seeds from several successive harvests without losing much yield.

Existing solutions to this are as much economic as agronomic. One strategy is for plant breeders to collect royalties from farmers who save seeds — as is done in countries such as Australia and the United Kingdom. Although this approach is reasonable for farmers who harvest substantial profits, it is less applicable to subsistence farmers in the developing world; for them, science might provide better solutions.

An international research effort to boost wheat yields by 50% by 2035 will be officially launched at this week’s meeting. The International Wheat Yield Partnership — a consortium of research
institutions including CIMMYT and the United Kingdom’s Biotechnology and Biological Sciences Research Council — is a long-term project that aims to raise US$100 million in the next five years.

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Researchers plan to use the cash to explore, for example, how to improve the way wheat photosynthesizes. Wheat, frankly, does it badly; it converts just 1% of incoming light to grain. Maize is three times more efficient; sugar cane eight times.

The map of the wheat genome remains a job half-finished. An estimated US$50 million is needed to map the remaining 20 of wheat’s 42 chromosomes. Obtaining the complete genome should accelerate the effort to make wheat more tolerant to heat and drought through both conventional breeding and genetic-modification techniques.

Crucial work to monitor the spread of wheat pathogens must continue. Borlaug championed this research through the Durable Rust Resistance in Wheat project led by Cornell University in Ithaca, New York, and the Borlaug Global Rust Initiative, a consortium of more than 20 institutions, which has its secretariat at Cornell. Famously, he said that “rust never sleeps”, and the continued spread of the devastating Ug99 stem-rust fungus in Africa and other new strains in Ethiopia (see page 404) demonstrate the truth of his words.

Today, yield is not the only impact by which agriculture is judged. The Intergovernmental Panel on Climate Change will next week report on farming’s direct and indirect consequences for the planet. The focus on the carbon footprint of food production is necessary, but the message cannot be boiled down to the misleading idea that all agricultural techniques bar organic farming are a plague on the environment.

Borlaug believed that increasing yields through the use of new and improved varieties, along with the responsible application of fertilizer and pesticides, could benefit natural ecosystems. Less land would need to be converted into agricultural production to grow food. Recent studies suggest that he was right (\textit{J. R. Stevenson et al. Proc. Natl Acad. Sci. USA 110, 8363–8368; 2013}).

Misguided opposition to some aspects of big agriculture, such as chemical-fertilizer use in the developing world, could stop many nations from growing the food they need. Objections should be saved for the irresponsible overuse of fertilizer in the West and Asia, which has led to widespread water and air pollution.

One of Borlaug’s guiding principles was that food is the moral right of all who are born into this world. He won an important battle against hunger, but the war continues.